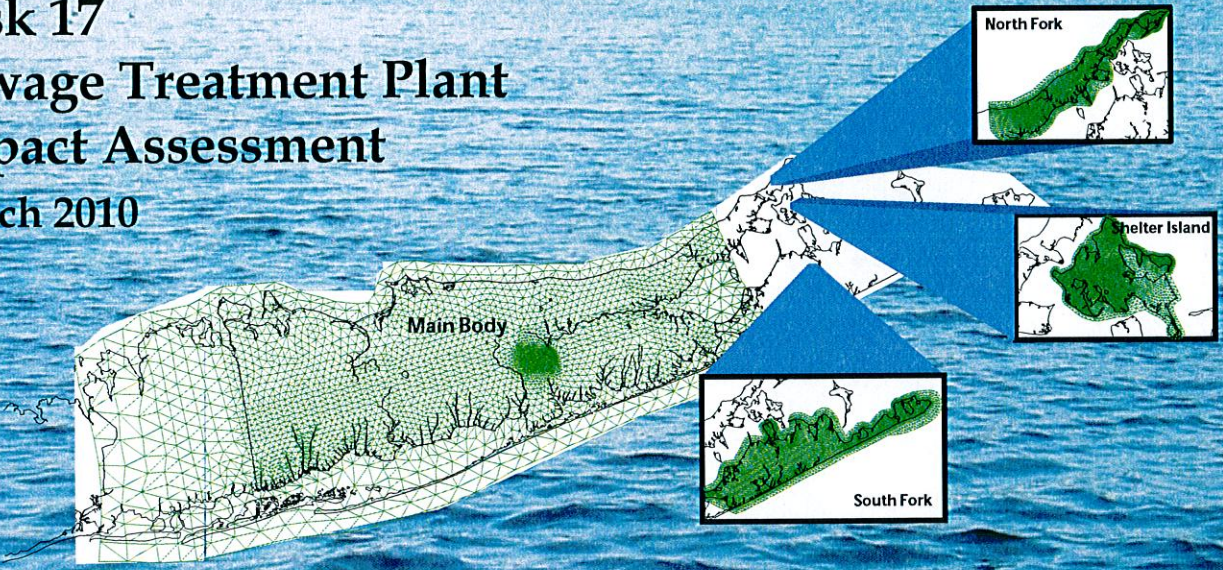
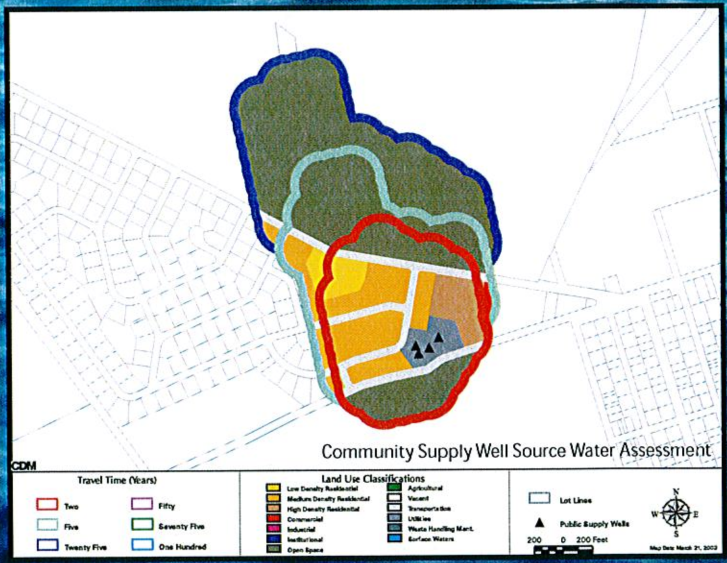
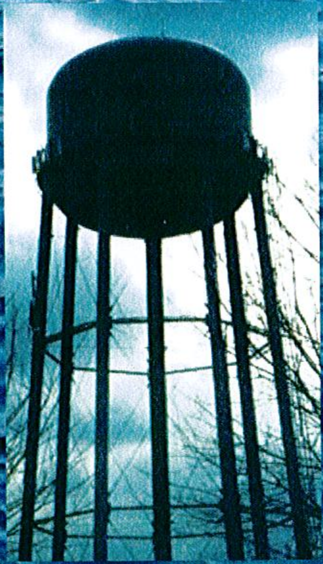
Comprehensive Water Resources Management Plan for Suffolk County

Task 17
Sewage Treatment Plant Impact Assessment

March 2010







CDM

Memorandum

To: *Martin Trent, SCDHS*

From: *CDM*

Date: *February 19, 2010 - Revised March 23, 2010*

Subject: *Task 17 – Sewage Treatment Plant (STP) Impact Assessment*

This memorandum presents the results of the groundwater flow and contaminant transport modeling conducted to simulate the potential impact of proposed sewage treatment plant (STP) discharges on area groundwater levels and groundwater quality. The areas selected by Suffolk County Department of Health Services (SCDHS) for this assessment were the (1) Kings Park/Smithtown Business Districts and (2) the Mastic/Shirley Business Improvement District (BID).

1.0 Model Development

1.1 Kings Park/Smithtown Business Districts

The existing Suffolk County regional groundwater flow model was used as the basis for the Kings Park/Smithtown area assessment. Because the node spacing of the regional groundwater flow model was approximately 3,000 feet in the area of interest, additional nodes and elements were added to provide a more accurate assessment of the discharge impacts to local water levels and water quality. Node spacing was adjusted to approximately 200 feet at the Kings Park STP (Suffolk County Sewer District No. 6) and former Kings Park Psychiatric Center, where leaching pools would be built to handle the additional treated flow. Node spacing in the Kings Park and Smithtown Business Districts, where sewering would occur, was adjusted to approximately 400 to 500 feet. The updated grid is shown in **Figure 1**.

All geologic and hydrologic data were interpolated from the regional model to the more highly discretized grid. Long term average conditions of precipitation, recharge and water supply pumping were incorporated into the model. In the existing regional model, the recharge of sanitary wastewater via on-site septic systems is simulated by returning 85 percent of the water pumped from a given node back to the top of the model at that node. While this approach was appropriate for the node spacing included in the regional model, a more refined approach was necessary to provide a more accurate representation of the localized water table impacts from sewering in the more detailed subregional model. Therefore, for the simulation of existing conditions, in the vicinity of the two business districts, eighty five percent of the water removed from the aquifer via supply pumping was simulated to be returned to the groundwater through on-site wastewater disposal systems by returning the water supply pumping evenly to the top of the model at nodes covering residential, commercial and industrial land uses of the Kings Park High, Smithtown Water District, and Central Island Intermediate pressure zones. Model-predicted stream baseflow in the Nissequogue River was also compared to the baseflow calculated by the calibrated regional model. Because of the much finer discretization, more nodes were available to represent the Nissequogue River. Slight adjustments in elevation were made to the new river nodes in the top model level, to better match the baseflow previously calculated by the regional model.

The model-predicted long-term steady state head contours for the upper glacial aquifer are shown in **Figure 2**. These were used to represent baseline existing conditions for comparison to simulated future projected conditions after sewering, to determine the potential decline of the water table in the areas receiving sewers and the increase in the water table in the vicinity of the leaching pools to be located at the former Kings Park Psychiatric Center.

1.2 Mastic/Shirley Business Improvement District

The sub-regional groundwater flow model developed for the Task 5-2 examination of future land use impacts in the Montauk Highway Corridor and Forge River watershed was used as the basis for the Mastic/Shirley Business District sewering assessment. Node spacing of the sub-regional model is approximately 50 feet in the BID, which provides excellent discretization for this assessment. The sub-regional model grid is shown in **Figure 3**. Additional details of the model development are documented in the Task 5.2 memorandum. The same approach to simulate the return of water supply pumping through on-site wastewater treatment systems used for the Kings Park/Smithtown assessment was used for this analysis.

The model-predicted long-term steady state head contours for the upper glacial aquifer are shown in **Figure 4**. These were used to represent existing conditions for comparison to simulated future projected conditions after sewering to determine the potential decline of the water table in the area receiving sewers and the water table increase in the vicinity of the proposed STP leaching pools located just east of the Brookhaven Airport and north of Sunrise Highway.

2.0 Modeling Approach and Results

2.1 Kings Park/Smithtown Business Districts

2.1.1 Model Inputs and Assumptions

The Kings Park/Smithtown assessment was developed based on the proposed 10 and 20 year service areas documented in the *Final Report Smithtown and Kings Park Sewering Feasibility Study* (Cameron Engineering, 2009). The projected wastewater flow from the two business districts and nearby developments is 611,785 gallons per day (gpd) after 10 years. After 20 years, wastewater flow is projected to increase to 802,001 gpd. These flows were used as the basis for creating 10 and 20 year steady state flow fields. In both future scenarios, the return of water supply pumping via on-site wastewater treatment systems in the business districts was eliminated, to represent the cessation of groundwater recharge from the on-site sanitary waste disposal systems after sanitary sewering of these areas. Discharges corresponding to the 10 and 20 year flows were added to simulate the return of the treated effluent to the proposed leaching pools that will be located approximately 3,000 feet from the STP at the former Kings Park Psychiatric Center property. The current plant permitted flow, 0.6 mgd, was simulated to be discharged to off-shore receiving waters. The inland discharge was distributed among four model nodes representing leaching pools covering approximately 60,000 square feet for the 10 year flow simulation, and 80,000 square feet (for the 20 year flow simulation, based on SCDHS design criteria of 10 gpd/sf of bottom area for filtered effluent. Nitrogen concentration in the effluent was assumed to be 5.2 mg/L, which is the limit for discharge to Long Island Sound.

Water supply pumping from nearby supply wells was also increased for the 10 and 20 year scenarios, corresponding to the increase in demand from new developments. For the 10 year scenario, the increase in pumping was simulated to be 282,377 gpd. For the 20 year scenario, the simulated increase in pumping was 472,593 gpd.

2.1.2 Water Table and Streamflow Impacts

In addition to the baseline flow field representing existing conditions (**Figure 2**), a second flow field was developed to represent steady-state conditions resulting from sewering of the Kings Park/Smithtown Business Districts and the return of 611,785 gpd to leaching pools located at the Kings Park Psychiatric Center. **Figure 5** depicts the change in heads in the upper glacial aquifer resulting from the 10 year flow (611,785 gpd) compared to the baseline simulation. In addition to sewering in the two business districts, the 10 year flow scenario includes anticipated flows from the Lumber Yard, R-6 Zone, Carlson Sand Pits, and Kings Park Psychiatric Center. The water table is predicted to decline by a maximum of 0.5 feet in the business districts due to the loss of onsite sanitary recharge. The water table increases due to the STP leaching pools are predicted to dissipate within 1,800 feet. **Figure 6** depicts the change in heads in the upper glacial aquifer resulting from the 20 year flow (802,001 gpd) compared to the baseline simulation. In addition to increased flow from the business districts, three more developments are anticipated to provide additional flows in the 20 year flow scenario – the Indian Head Road Development, St. Catherines, and St. Johnland. The water table is predicted to decline by a maximum of 1 foot in the business districts due to the loss of onsite sanitary recharge and water table increases due to the STP leaching pools are predicted to dissipate within 2,000 feet.

Current average Nissequogue River baseflow is approximately 40 to 44 cubic feet per second (cfs). Groundwater discharge to the non-tidal portion of the Nissequogue River is simulated to decline by 0.5 cubic feet per second (cfs) when sewer flows in the two business districts total 611,785 gpd, and by 0.6 cfs when sewer flows total 802,001 gpd.

2.1.3 Contaminant Transport Simulations

The contaminant transport code DYNTRACK was used to simulate the impact of the Kings Park STP discharges downgradient of the leaching pools. Contaminant transport runs were completed using the steady state flowfield created by the 611,785 gpd flow for the first 20 years, followed by the 802,001 gpd flow from year 20 to year 30.

Figure 7 shows the particle cloud resulting from a 10 year release of particles representing treated sanitary effluent discharged from the STP leaching pools. The particle cloud is simulated based on estimates for dispersion typically used for Long Island aquifers and successfully used in many previous contaminant transport simulations. Single particle tracks were also evaluated, using no dispersion parameter, to provide an estimate for the average time of travel to discharge to the tidal portion of the Nissequogue River. The particles representing treated sanitary effluent discharged at the STP leaching pools are simulated to travel to the Nissequogue River in as early as 6 years and as late as 24 years, depending on whether they migrate deeply enough in the aquifer system to encounter the Smithtown Clay, which is depicted in the model to begin approximately 2,000 feet downgradient of the STP leaching pool discharge location. **Figure 8** shows the particle cloud resulting from a 30 year release of particles from the STP leaching pools. The area of high particle density roughly 1,000 feet south of the river is a result of the particles encountering the Smithtown Clay.

The results of the contaminant transport run were assessed to determine the impact of nitrogen on area groundwater quality. **Figures 9, 10 and 11** depict nitrogen concentration isopleths downgradient of the leaching pools after 10, 20, and 30 years respectively. The isopleths reflect the maximum increase in nitrogen concentration at each node, throughout the entire vertical extent of the affected portion of the aquifer. The concentrations shown do not account for background levels of the nitrogen. To estimate the total concentration, background should be added. Based on a review of private well data from the area, typical background nitrogen concentrations (as represented by nitrate and nitrites+nitrates sample results from 2000 through 2006) for the upper glacial aquifer in the Kings Park and

Smithtown area range from below detectable levels to 13.10 mg/L and average approximately 2.8 mg/L.

The maximum increase in nitrogen concentration in groundwater from STP effluent at discharge nodes of the Nissequogue River ranges between 1.0 and 2.0 mg/L; however sewering will result in a net reduction in nitrogen discharge to groundwater; as the STP will remove a much greater amount of nitrogen from the wastewater than conventional on-site disposal systems or older cesspool systems.

2.2 Mastic/Shirley Business Improvement District

2.2.1 Model Criteria and Assumptions

The Mastic/Shirley assessment was developed based on the proposed service area described as "Alternative 3" of the Suffolk County Department of Public Works Report *Mastic – Mastic Beach – Shirley Sewering Feasibility Study* (2009). The projected wastewater flow from the BID corresponding to this service area is 400,000 gpd. This service area also matches closely to the 380,297 gpd service area described in the Henderson and Bodwell (2004) report. The 400,000 gpd flow was used as the basis for creating a future condition steady state flow field. In the future scenario, the return of wastewater via on-site wastewater disposal systems in the BID was eliminated to represent sewering. A discharge of 400,000 gpd was added to simulate the return of treated effluent to leaching pools to be located at the south end of the Brookhaven Airport. The discharge was spread over four model nodes representing leaching pools covering approximately 40,000 square feet. Nitrogen concentration in the effluent was assumed to be 6.0 mg/L.

2.2.2 Water Table and Streamflow Impacts

In addition to the baseline flow field representing existing conditions (**Figure 4**), a second flow field was developed to represent steady-state conditions resulting from sewering of the Mastic/Shirley BID and the return of flows to leaching pools located at the proposed STP site east of the airport. **Figure 12** depicts the change in heads compared to the baseline simulation. Water table heads are predicted to decrease by less than 0.25 feet in the BID due to the loss of onsite sanitary recharge. Water table heads are predicted to increase by no more than 0.9 feet in the vicinity of the STP leaching pools.

Groundwater discharge to the Forge River is not predicted to change as a result of sewering in the BID and discharge at the proposed STP site.

2.2.3 Contaminant Transport Simulations

The same approach used to evaluate nitrogen impacts from the Kings Park STP discharge was used to determine nitrogen impacts to the upper glacial water table downgradient of the proposed STP near the Brookhaven Airport. Contaminant transport runs were completed using the steady state flow created after sewering the Mastic Shirley BID has been complete for 30 years.

Figure 13 shows the particle cloud resulting from a 30 year release of particles from the STP leaching pools. At the location of the Main Street Mastic wellfield, particles are simulated to migrate to a maximum depth of approximately 300 ft below mean sea level (msl), using a long term total wellfield pumping rate of 1,053 gallons per minute. Supply well S-112780 is screened from 371 to 474 feet below msl, and is therefore not predicted to be influenced by the STP discharge at the model simulated pumping rate.

Single particle tracks were also evaluated, using no dispersion parameter, to provide an estimate for the time of travel to discharge to the Forge River. The particles from the STP leaching pools discharge to the Forge River between 14 and 23 years after reaching the water table.

The results of the contaminant transport run were assessed to determine the impact of nitrogen on area groundwater quality. **Figure 14** depicts nitrogen concentration isopleths downgradient of the leaching pools after 30 years of continuous discharge. The isopleths reflect the maximum concentration at each node, throughout the entire vertical extent of the effected portion of the aquifer. The concentrations shown do not account for background levels of these constituents. To estimate the total concentration, background should be added. Based on a review of private well data from the area, typical background nitrogen concentrations (as represented by nitrate and nitrites+nitrates sample results from 2000 through 2006) for the upper glacial aquifer in the Mastic/Shirley area range from below detectable levels to 16.4 mg/L and average approximately 4.2 mg/L (although the median value of the 94 samples examined was only 2.35 mg/L). Sewering in the BID, however, will result in a net reduction in nitrogen discharge to groundwater as the STP will remove a much greater amount of nitrogen from the wastewater than do on-site wastewater disposal systems. Therefore, background concentrations are expected to decrease as a result of sewering in the BID. The net contribution of nitrogen to the upper glacial aquifer and ultimately the Forge River are expected to decline as a result of sewering and treatment at the STP prior to discharge.

The decision to construct sanitary sewers requires careful evaluation of a number of site-specific costs and benefits including:

- Presence of a nearby existing wastewater treatment facility with available capacity, or a potential site for a new facility,
- Construction costs,
- Operation and maintenance costs,

- Groundwater quality improvements and impacts on downgradient supply wells,
- Improvement on downgradient surface water quality,
- Impacts on area wetlands and stream baseflow, and
- Potential ability to increase development density in the sewered area, and resulting impacts on County, local and school taxes.

Suffolk County has commissioned studies of a number of areas, including the two simulated for this task, to assess the feasibility of providing sanitary sewers.

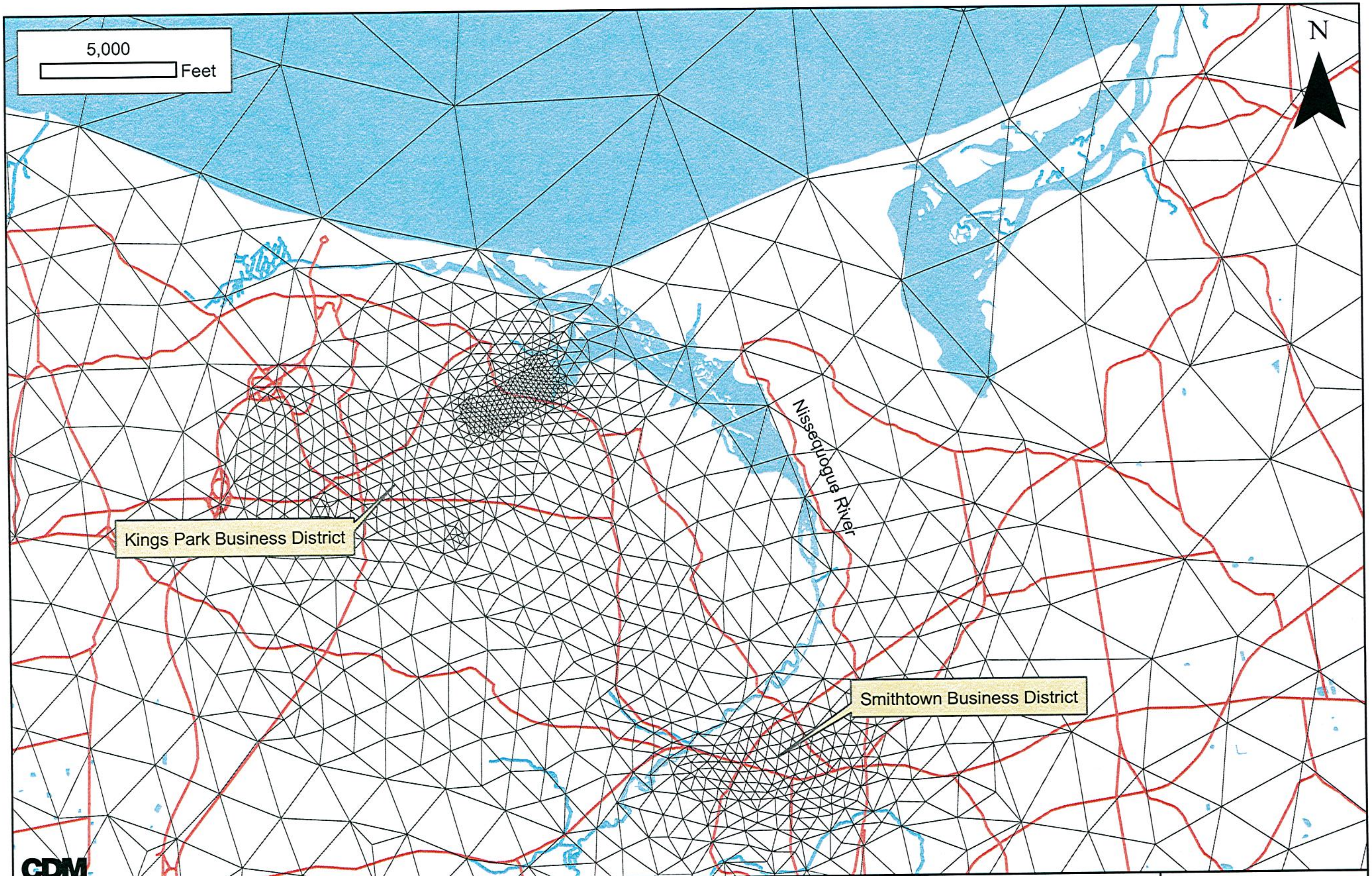
3.0 References

Cameron Engineering, 2009. *Final Report Smithtown and Kings Park Sewering Feasibility Study*

Camp Dresser & McKee, 2008. Comprehensive Water Resources Management Plan; Task 5.2 Memorandum: *Land Use Impacts*

Henderson and Bodwell, 2004. *Engineering Analysis for a Wastewater Treatment Plant and Collection System to Service a Mastic/Shirley Business Improvement District.*

Suffolk County Department of Public Works, 2009. *Mastic – Mastic Beach – Shirley Sewering Feasibility Study.*



Updated Regional Model Grid for Kings Park/Smithtown STP Impact Assessment

Figure 1

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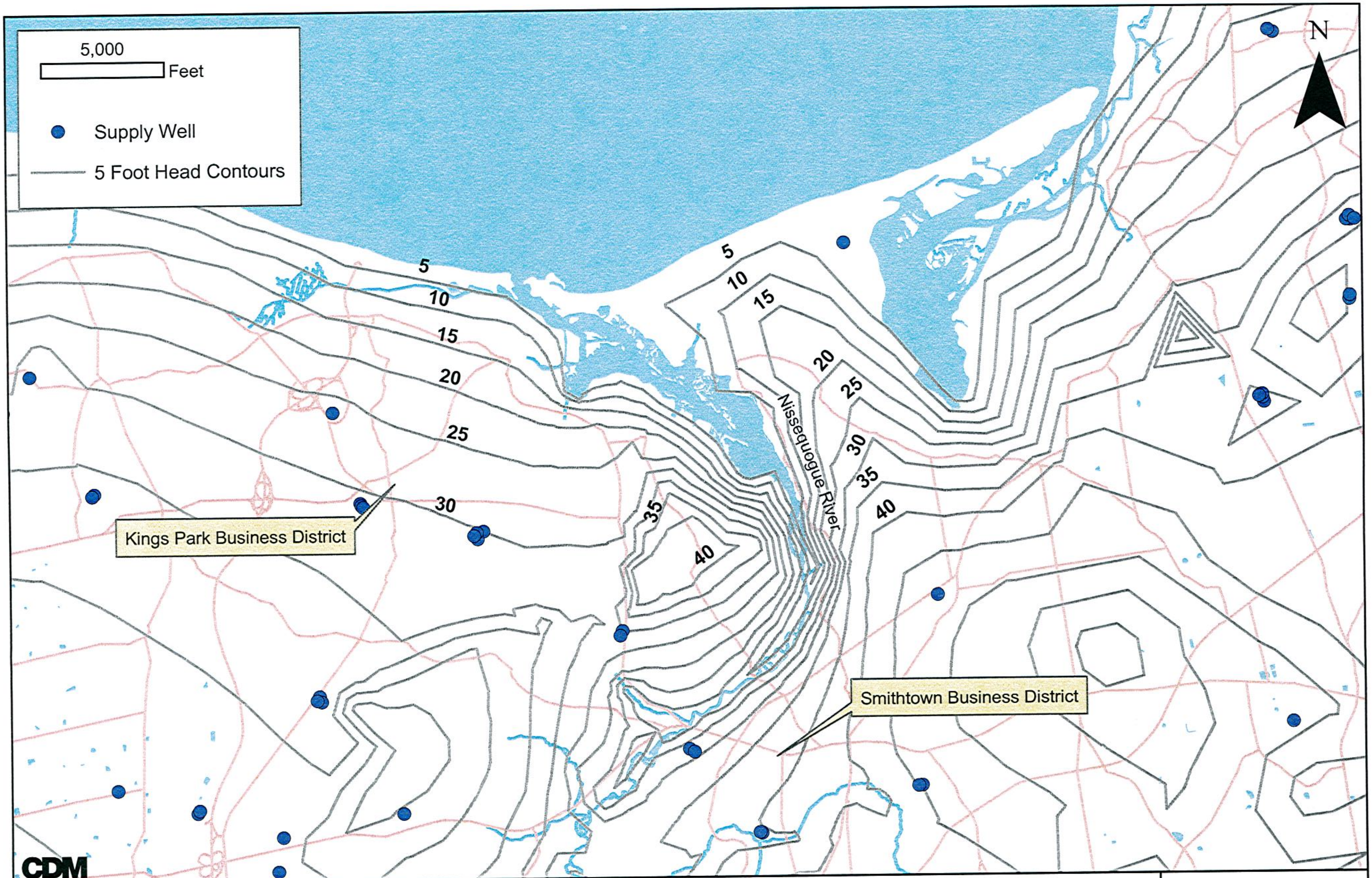

Baseline Upper Glacial Head Contours (No Sewering)

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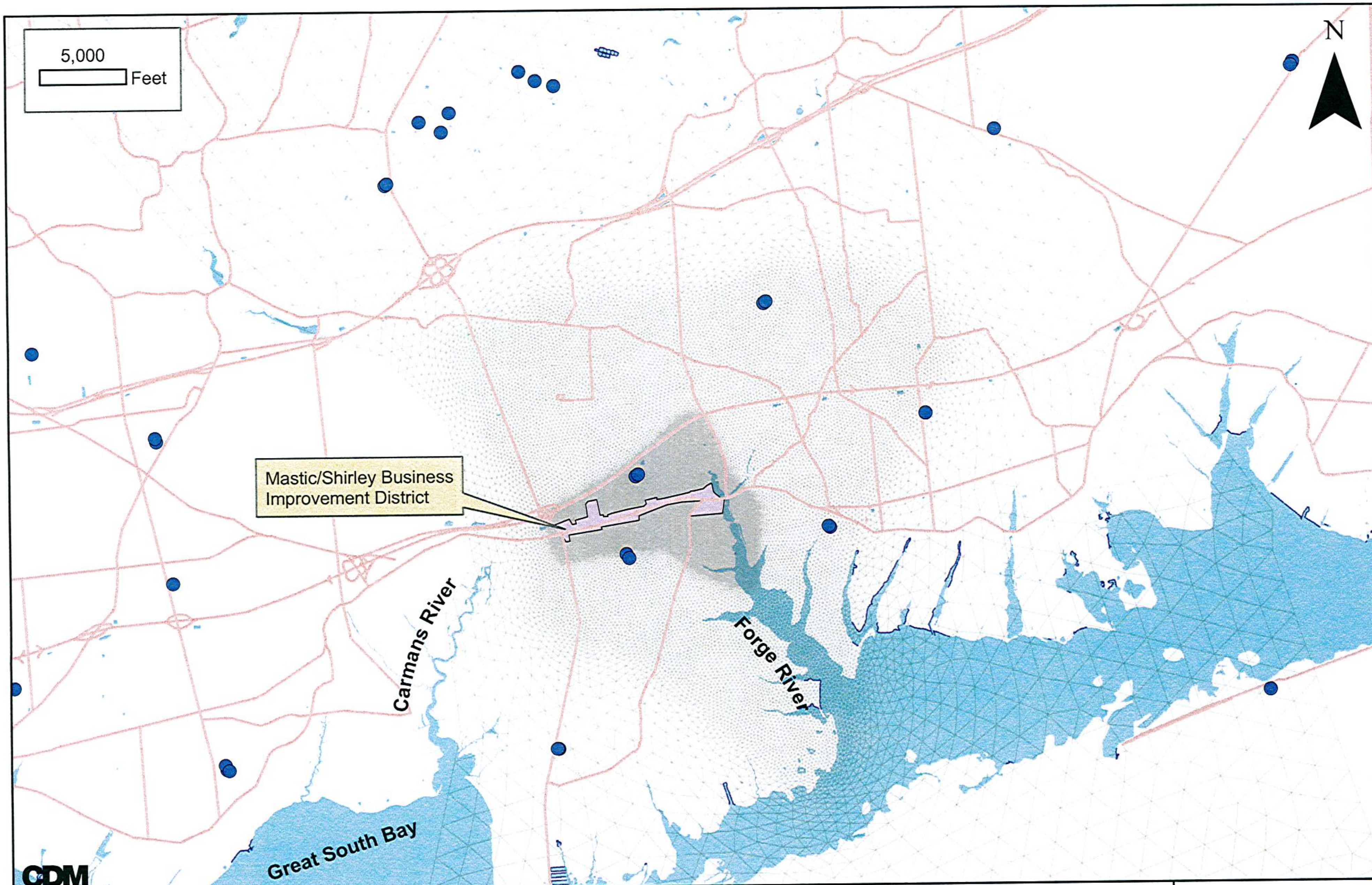
Figure 2



Sub-Regional Model Grid for Mastic/Shirley
STP Impact Assessment

Figure 3

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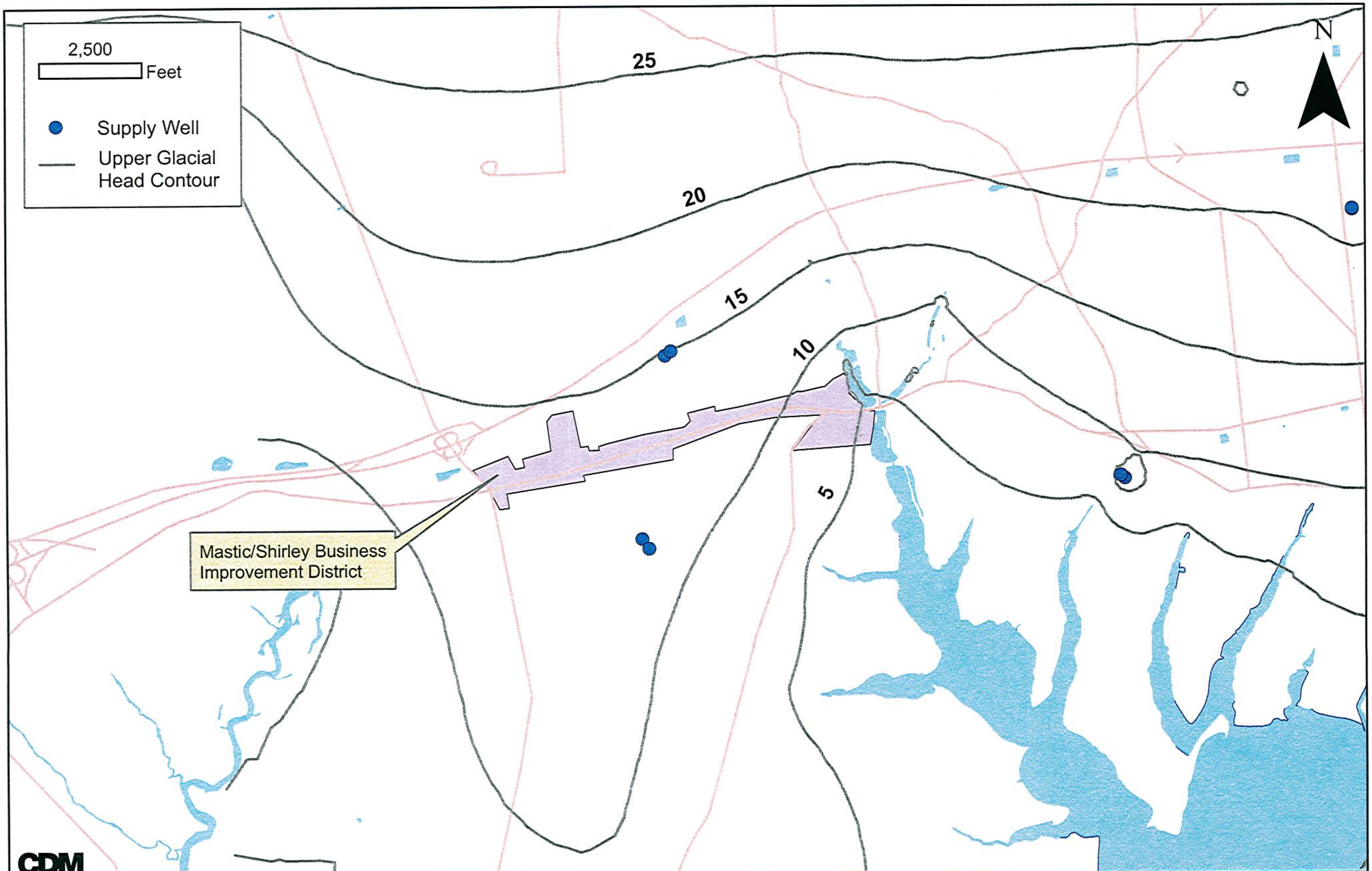

Baseline Upper Glacial Head Contours in Mastic/Shirley (No Sewering)

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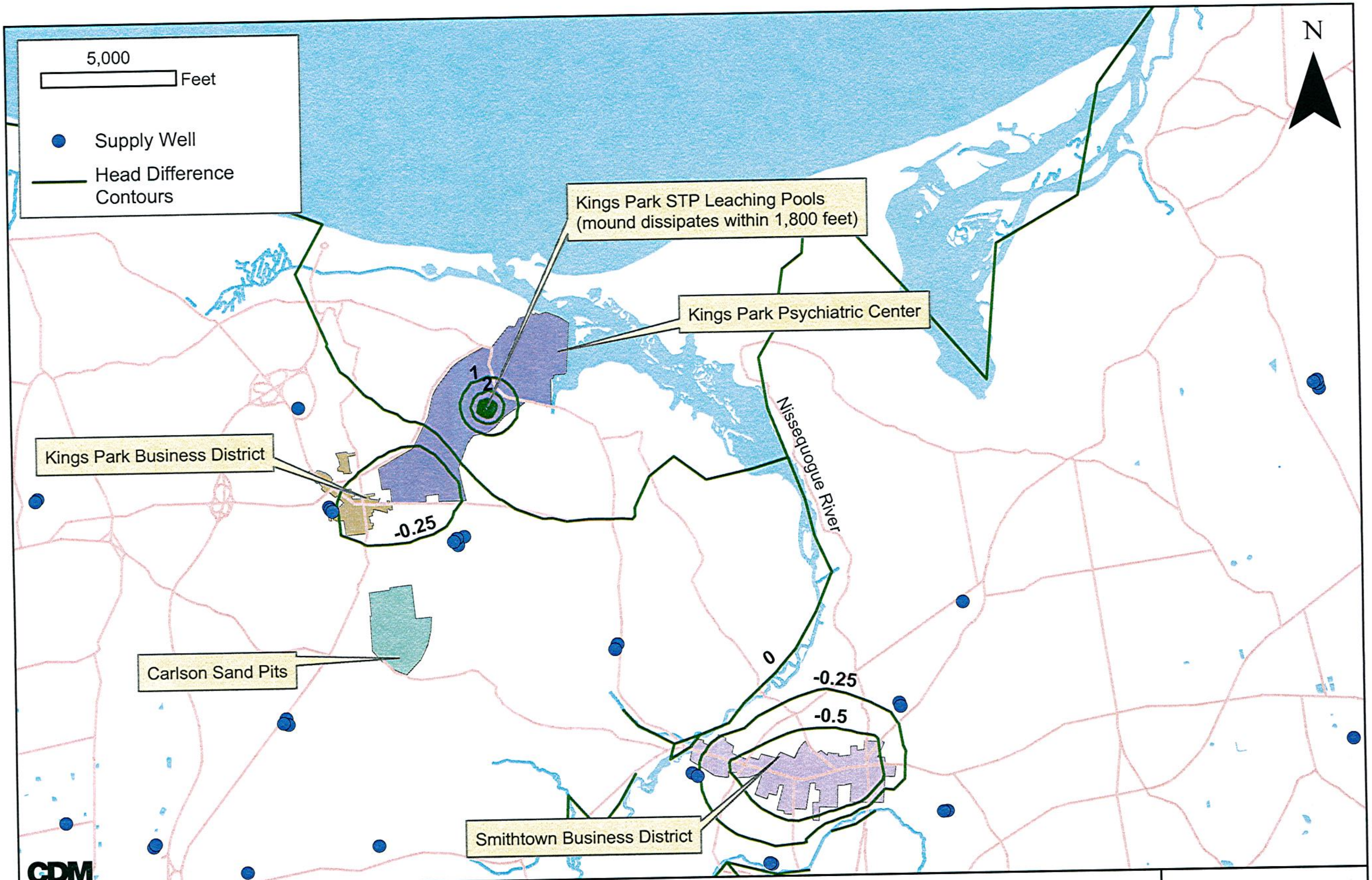
Figure 4



Change in Upper Glacial Aquifer Heads Corresponding to the 10 Year Flow (611,785 gpd)

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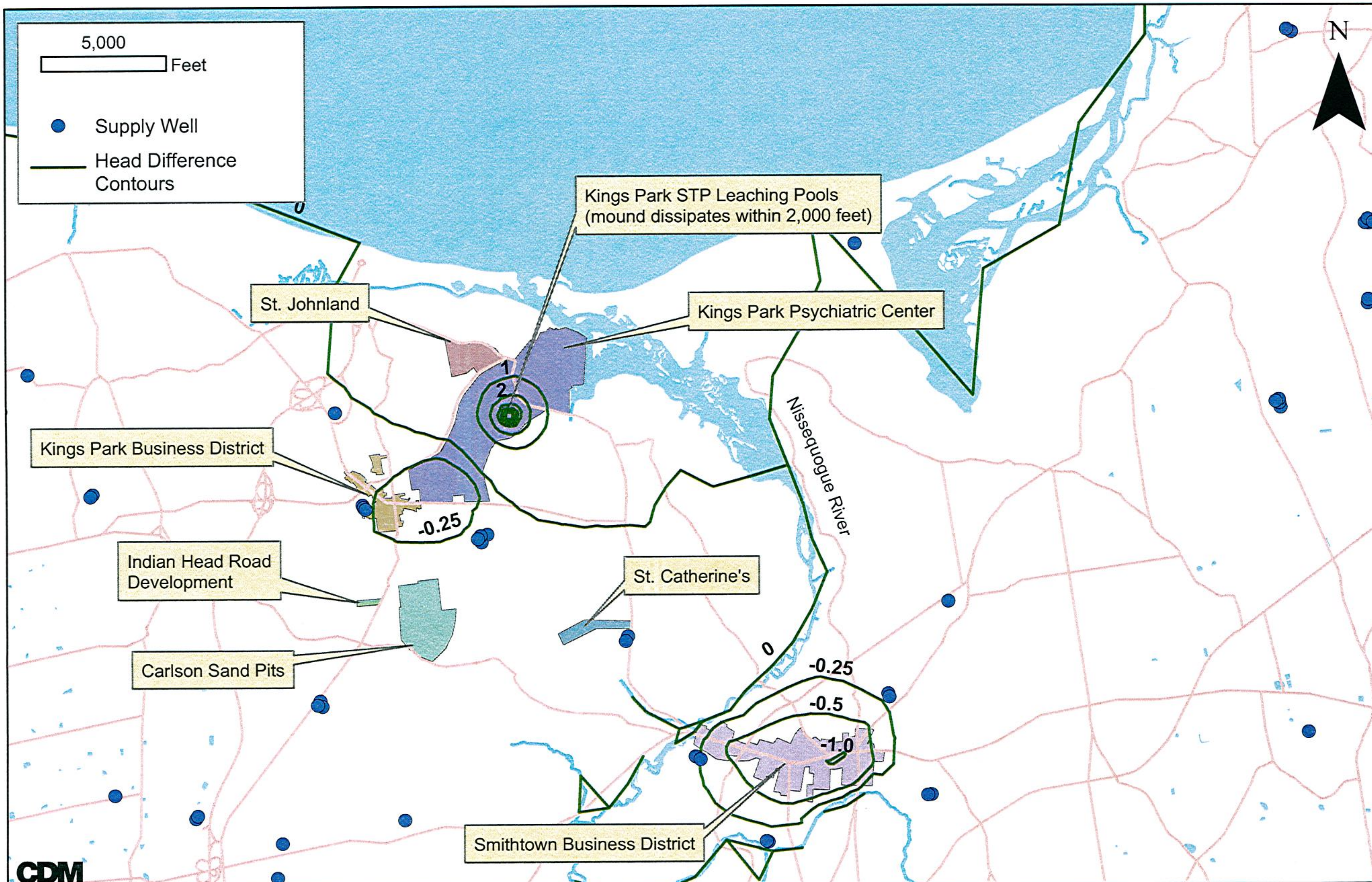
Figure 5



Change in Upper Glacial Aquifer Heads Corresponding to the 20 Year Flow (802,001 gpd)

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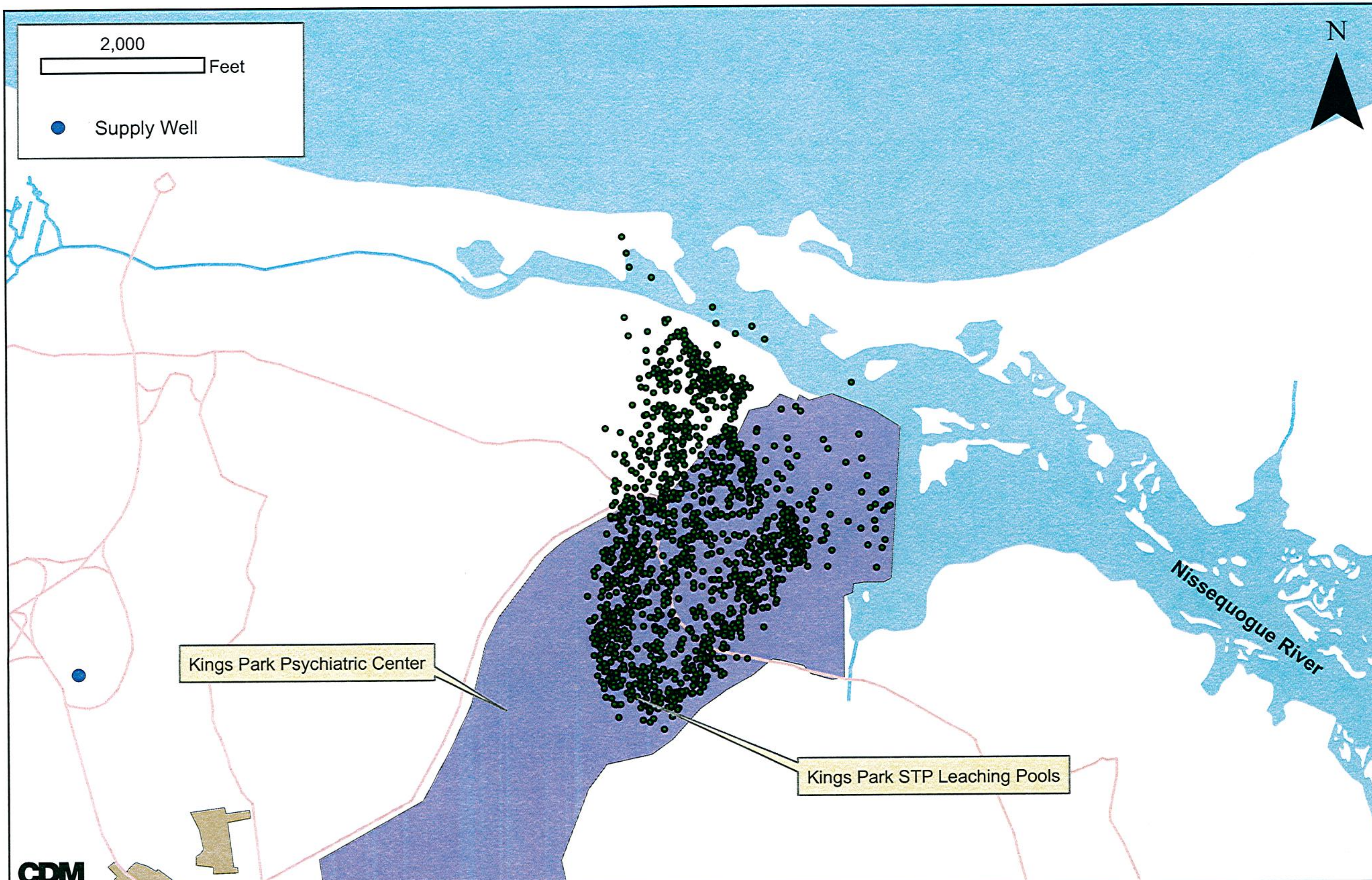
Figure 6



Ten Year Particle Cloud from the Kings Park STP

Figure 7

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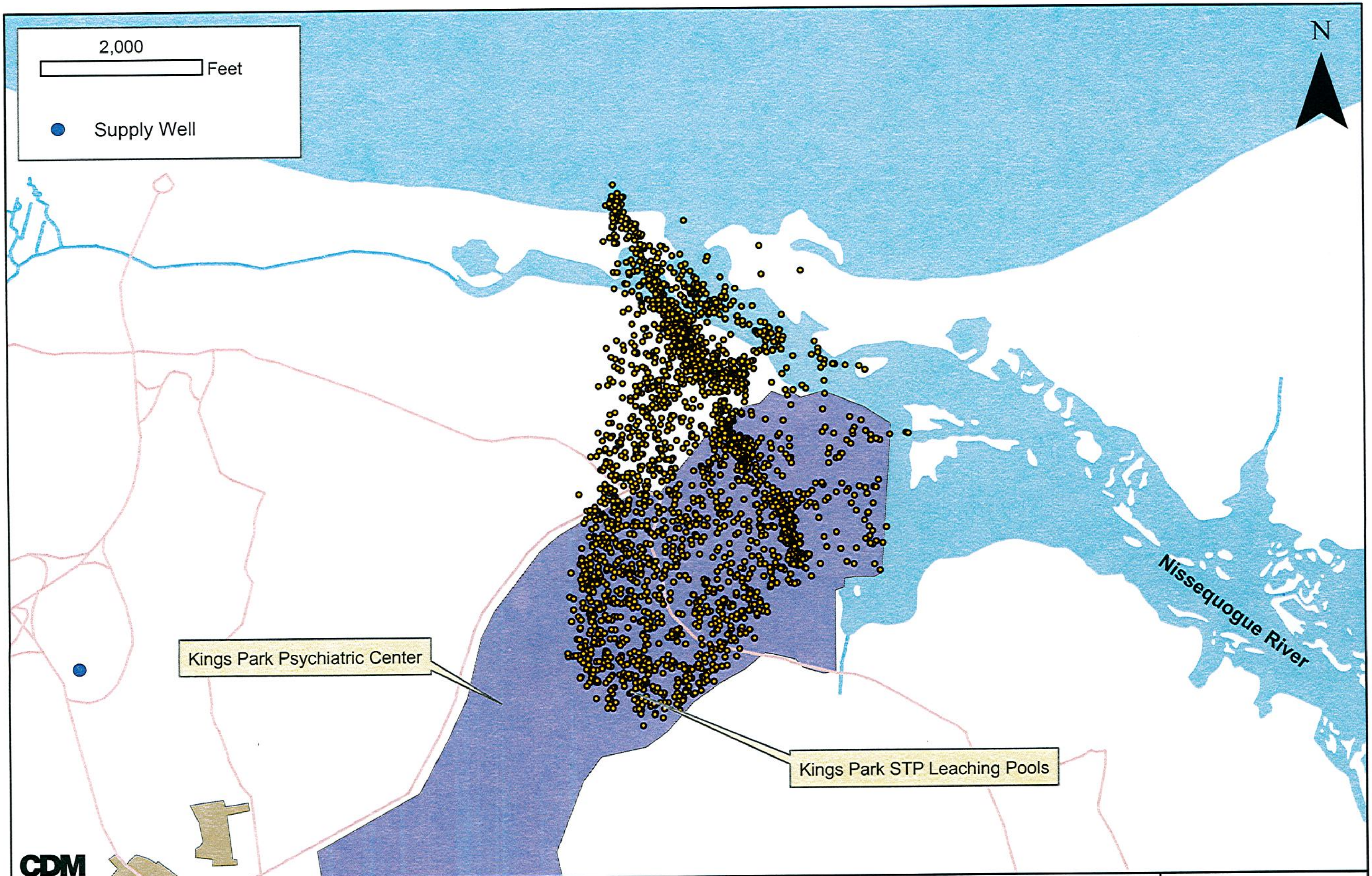

Thirty Year Particle Cloud from the Kings Park STP

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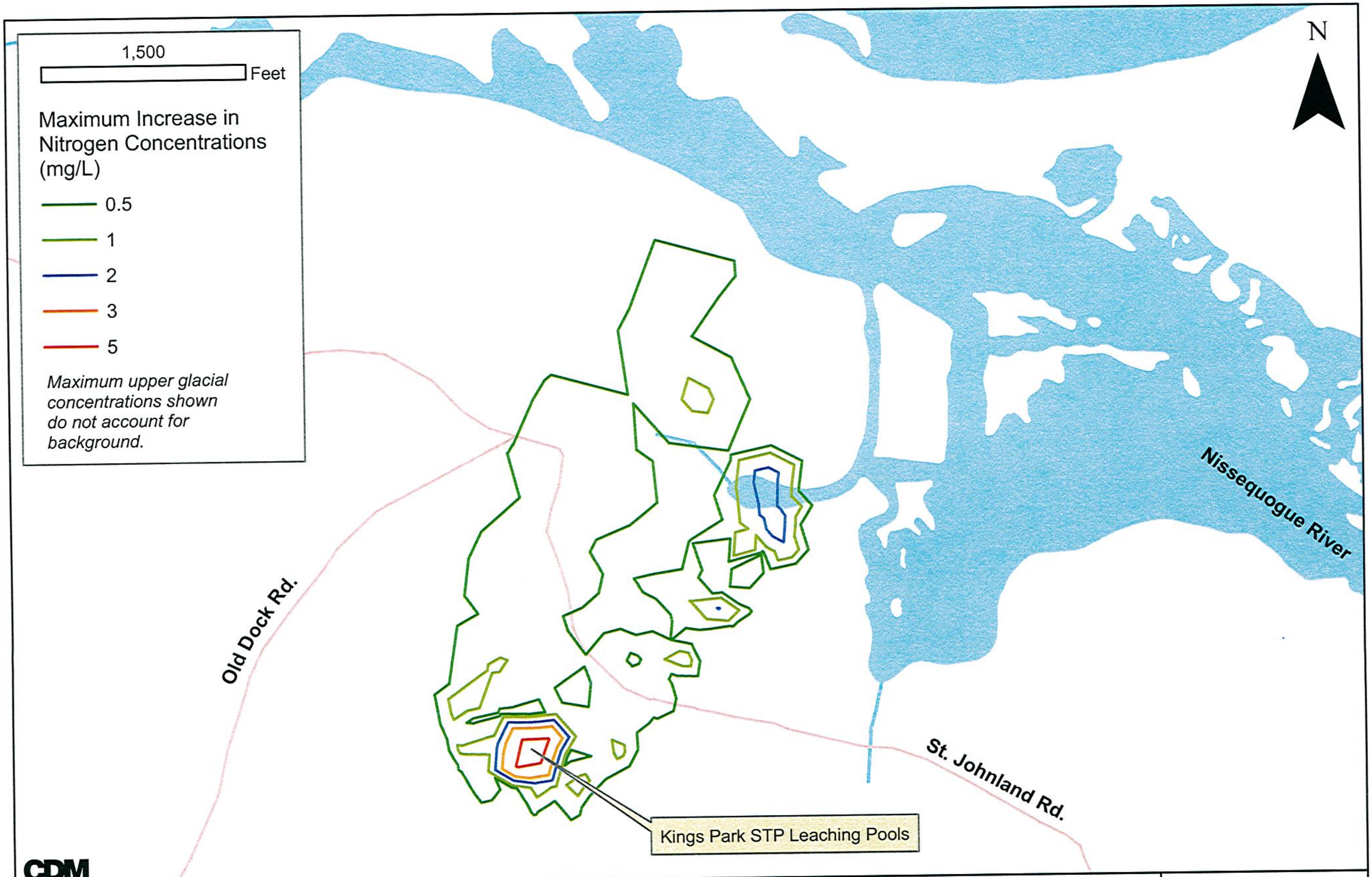
Figure 8



Maximum Increase in Nitrogen Concentrations in the Upper Glacial Aquifer after 10 Years of Kings Park STP Discharge

Figure 9

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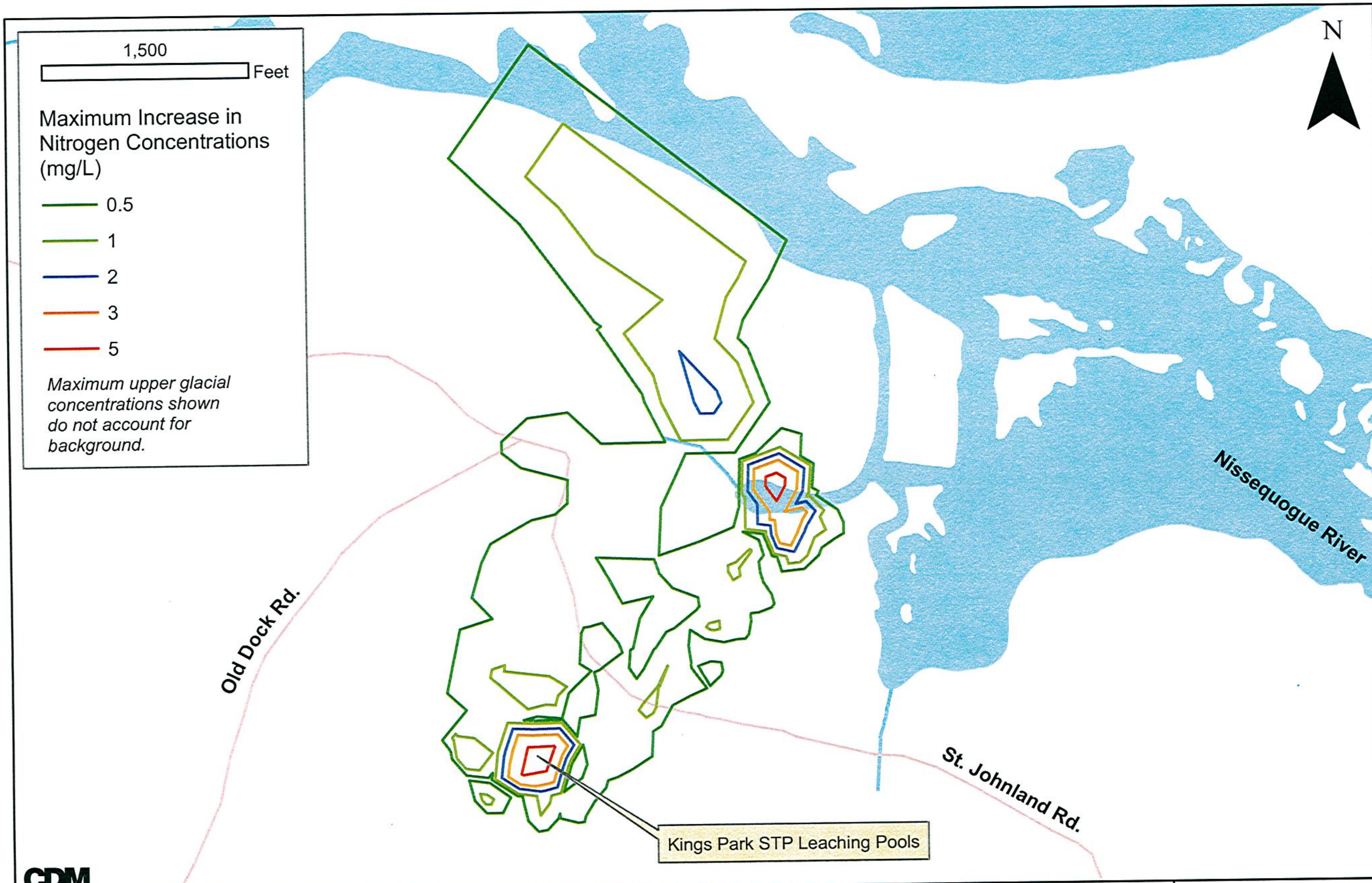

Maximum Increase in Nitrogen Concentrations in the Upper Glacial Aquifer after 20 Years of Kings Park STP Discharge

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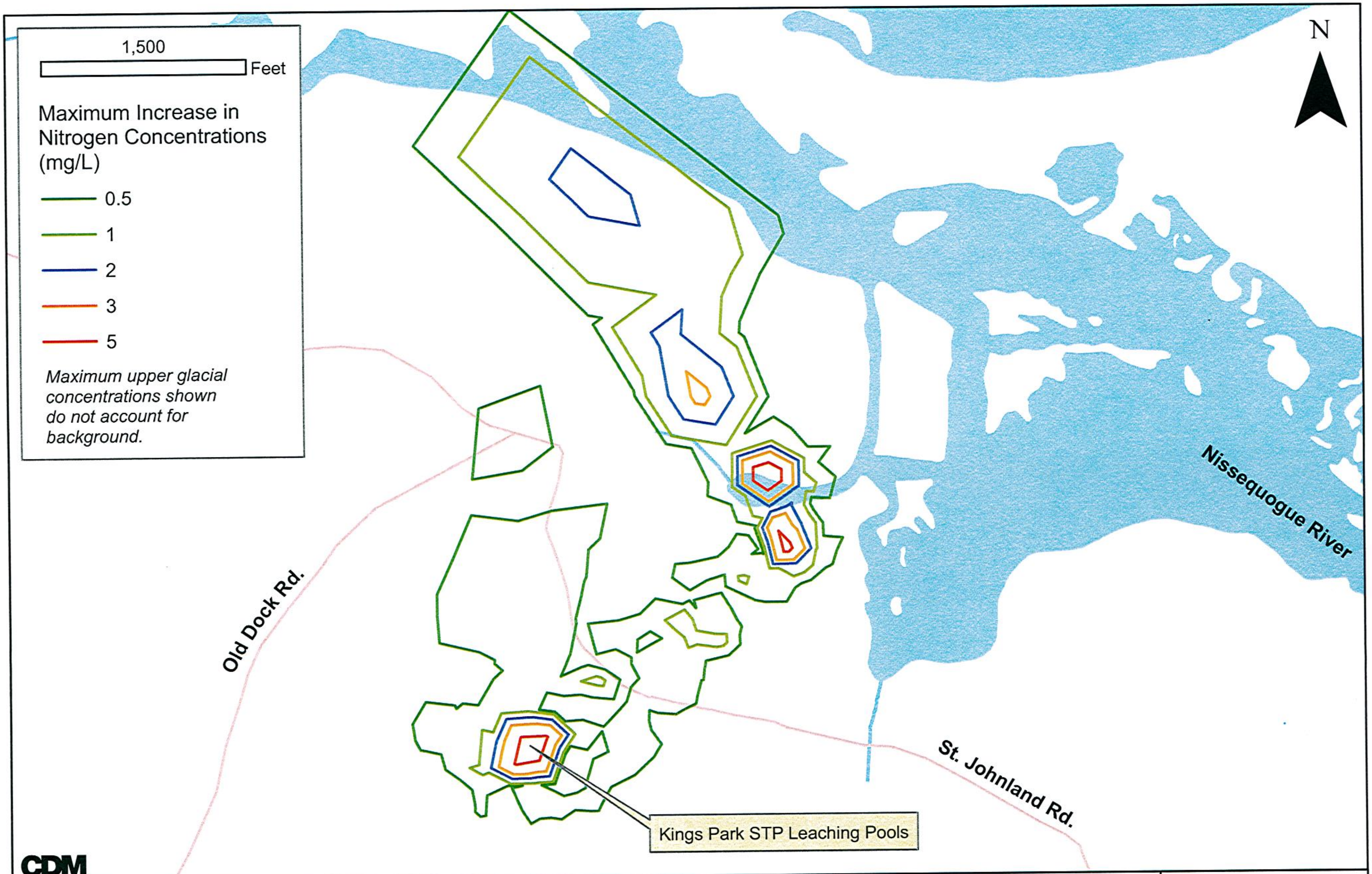
Figure 10



Maximum Increase in Nitrogen Concentrations in the Upper Glacial Aquifer after 30 Years of Kings Park STP Discharge

Figure 11

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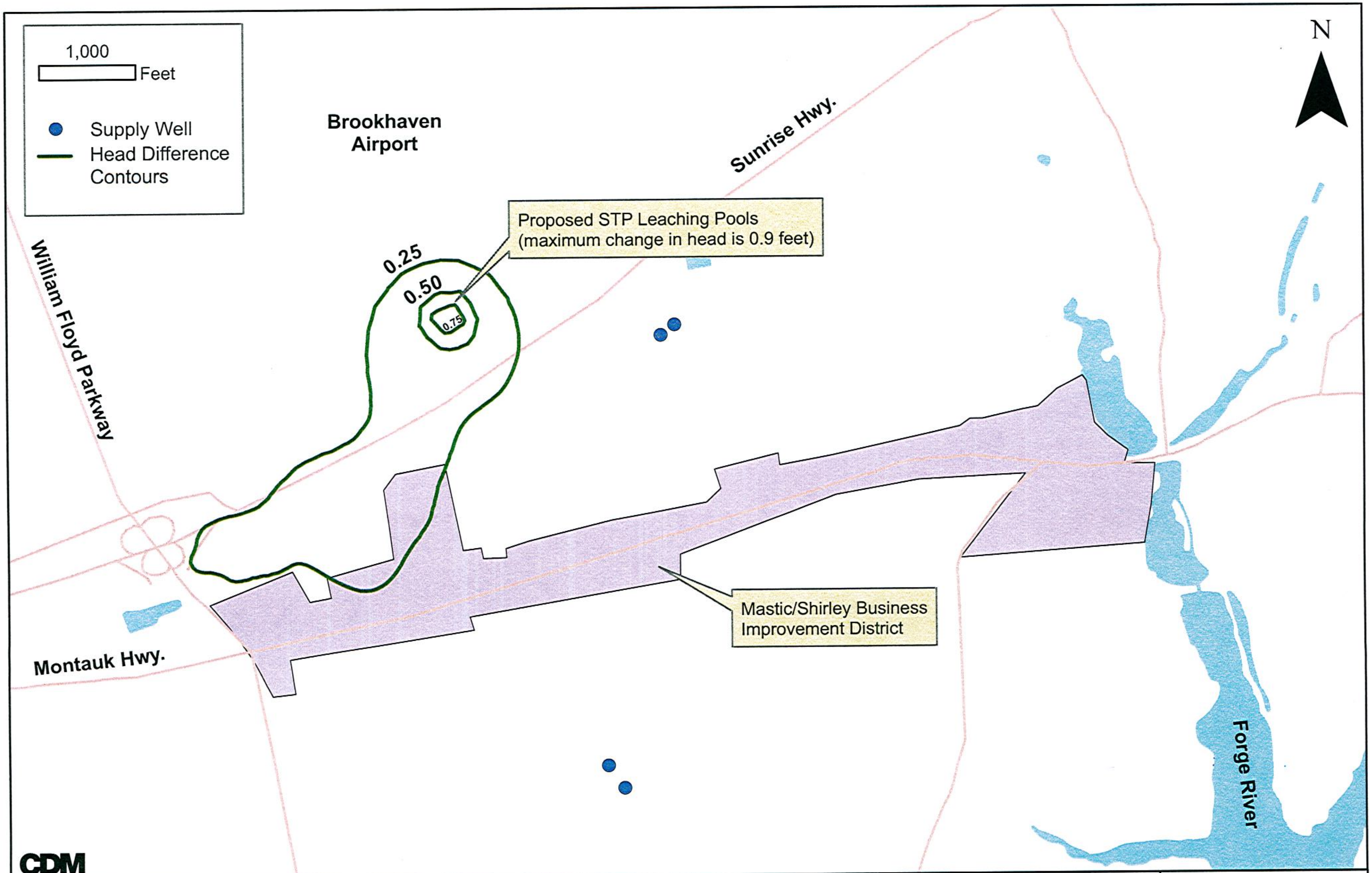

Change in Upper Glacial Aquifer Heads Following Sewering in the BID and 400,000 gpd Discharge at STP Leaching Pools

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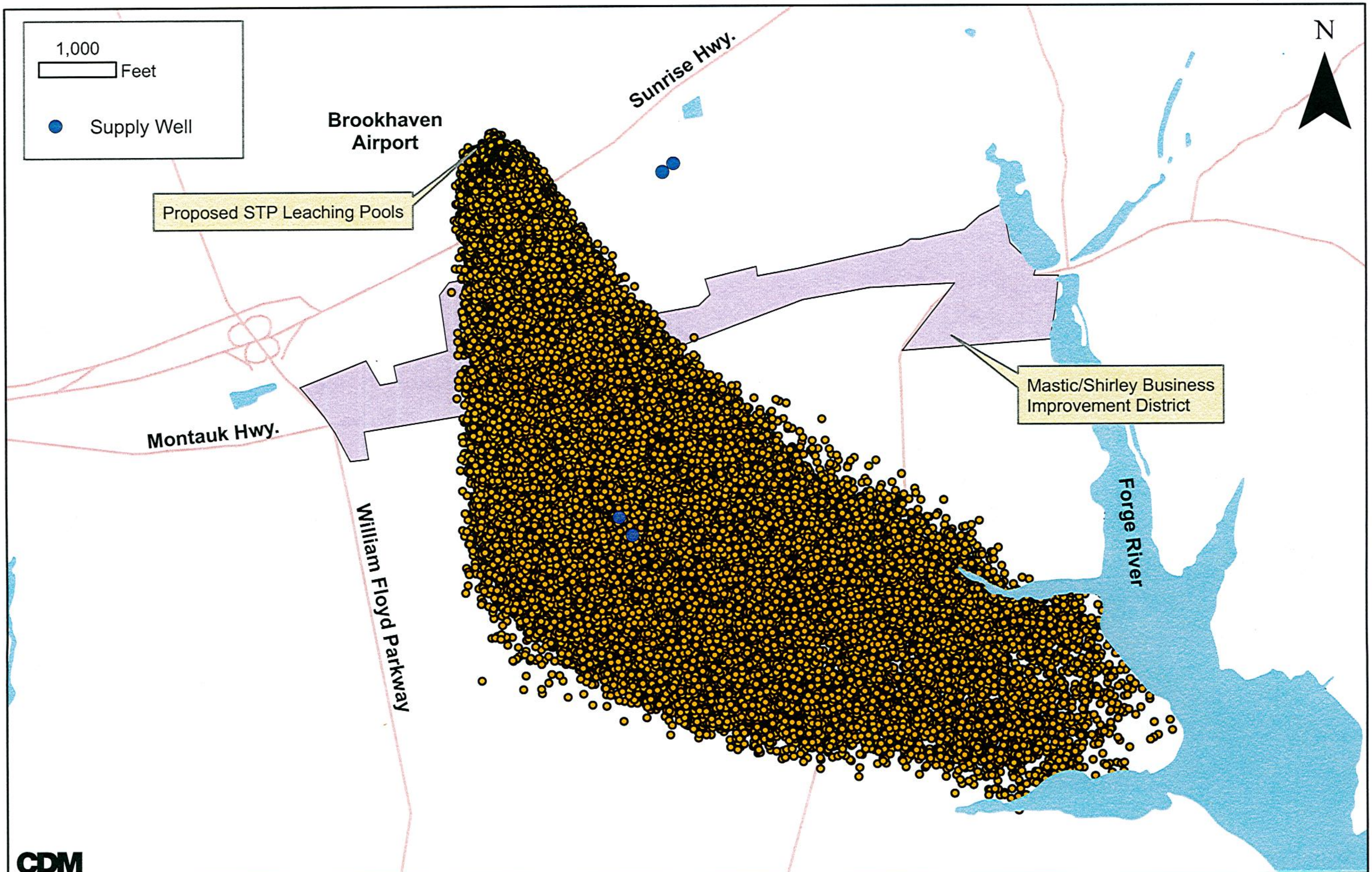
Figure 12



Thirty Year Particle Cloud from the Proposed STP Adjacent to the Brookhaven Airport

Figure 13

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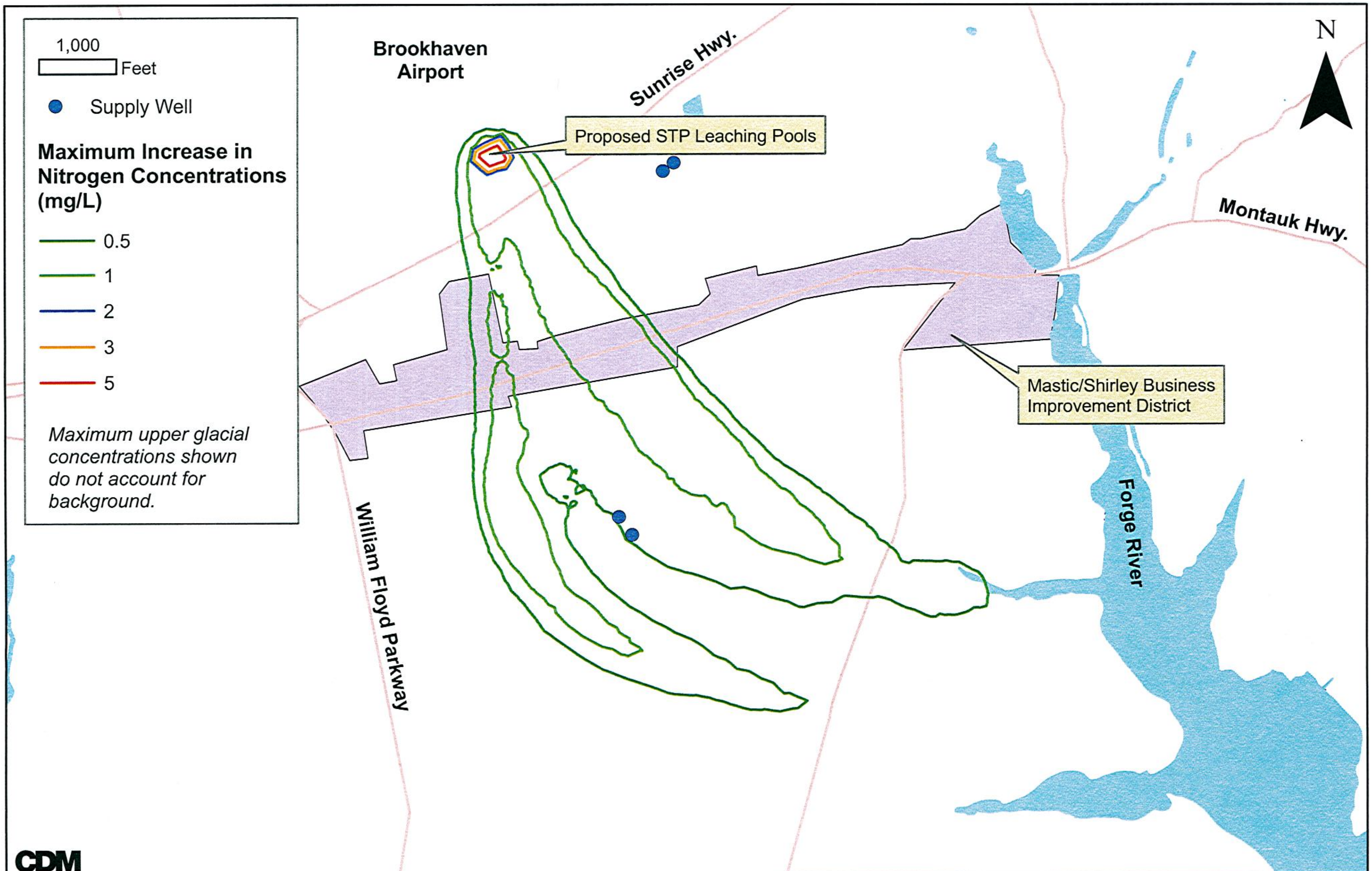

Maximum Increase in Nitrogen Concentrations in the Upper Glacial Aquifer after 30 Years of STP Discharge

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Figure 14